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WATERTOWN ARSENAL LABORATORY

EXPERIMENTAL REPORT

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Metallurgical Examination of [illegible] of Commercial and Springfield Armory [illegible]

DTIC ELECTE [illegible]

BY

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WATERTOWN ARSENAL
WATERTOWN, MASS.

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Watertown Arsenal Laboratory
Report No. 739/37
Problem No. R-1.1

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BAYONETS

Metallurgical Examination of Bayonets of Commercial and Springfield Armory Manufacture

OBJECT

To determine Method of Heat Treatment to Provide the Strongest and Most Durable Bayonets.

SUMMARY OF RESULTS

1. The method of heat treatment believed to provide the strongest and most durable bayonets is as follows:

A. Heat in a lead or salt bath with the bayonet immersed from the blade point to the pommel. The temperature of the bath and the time of heating should be chosen to insure adequate hardenability. The means used to support the bayonet should not prevent any portion from attaining the temperature of the heating bath and should not interfere with uniform quenching.

B. Quench with a minimum of delay into oil maintained at or near room temperature.

C. Temper to result in a uniform hardness in the range of Rockwell "C" 46 to 52.

2. To prevent the formation of grain boundary carbide network and consequent brittleness, a uniform rate of air cooling from the forging heat is essential. Also, care should be taken not to anneal bayonets at too high a temperature.

3. WD-1080 steel is considered to be the optimum composition for bayonets from the standpoint of conservation of strategic elements, adequate hardenability, potential toughness, and ability to retain keenness of cutting edge.

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INTRODUCTION AND TEST PROCEDURE

At the request of the Office, Chief of Ordnance, (SPOTS)* a metallurgical examination of nine lots of M1 and M1905 bayonets was carried out in an effort to determine a method of heat treatment to provide the strongest and most durable bayonets. It was revealed by the Ordnance Office that reports had been lately received from the field regarding numerous breakages of bayonets manufactured by the Pal Blade Company. The breakage uniformally occurred in the tang immediately to the rear of the bolster which supports the guard. Investigation by the Ordnance Office determined that since 1923, and possibly considerably before that time, the tangs of M1905 and M1 bayonets were not heat treated, possibly with the mistaken idea of providing a soft tang which would bend rather than break in use. It was found that the heat treatment as used by the Pal Blade Company provided an especially poor grain structure at the section of the tang directly to the rear of the bolster. The Pal Blade Company was requested to heat treat the blade and tang completely to the pommel. Preliminary tests of bayonet blades heat treated in this manner have indicated that they are superior to those treated in the previous manner.

The bayonets received at this Arsenal for examination consisted of the following nine lots, each containing 25 bayonets:

Lot	Type of Bayonet	Manufacturer	Year of Mfg.	Information on Heat Treatment
A	M1	Pal Blade Company	1943**	Heat treated tangs
B	M1	Pal Blade Company	1943**	Unheat treated tangs
C	M1	Pal Blade Company	1943**	Current or late mfg.
D	M1	American Fork & Hoe Company	1943**	Current or late mfg.
E	M1	Utica Cutlery Company	1942***	Current or late mfg.
F	M1	Union Fork & Hoe Company	1943**	Current or late mfg.
G	M1	Oneida Ltd.	1943	Current or late mfg.
H	M1905	Wilde Drop Forge & Mfg. Company	1943	Current or late mfg.
I	M1905	Springfield Armory	1906 to 1918****	----------------------

* O.O. 474.7/1702 - W.A. 474.8/74 (See Appendix C)

** Year of manufacture was not stamped on bayonets but probably is 1943.

*** Only 9 bayonets of this lot were heat treated by the Utica Cutlery Co. All 25 bayonets of this lot were originally of the M1905 type and were modified to the M1 type by the Utica Cutlery Co.

**** Bayonets of all years from 1906 to 1918 with the exception of 1910 were submitted.

The procedure in this examination consisted of the following steps:

(1) Determination of chemical composition of bayonets representing each lot.
(2) Rockwell "C" hardness surveys taken on longitudinal sections of bayonets representing each lot. The sections chosen included the tang up to the pommel and from three to five inches of the blade as measured from the front of the guard. A typical section is shown in Figure 1. Each section was ground parallel to and for a distance of 3/16" from the flat edge or back side of the blade. Hardness readings were taken 1/4" apart starting at the reference point in line with the front of guard. In reporting the results of the hardness surveys, the direction of the blade point is noted as positive whereas the direction of the pommel is noted as negative.

(3) Microexamination of the longitudinal sections of representative bayonets of each lot previously subjected to hardness surveys. The structure of the critical section* and of the portion of the blade possessing maximum hardness was determined for bayonets of each lot. In addition, examination was made of the tang near the pommel and of regions of hardness transitional zones where necessary to explain hardness variations.

RESULTS AND DISCUSSION

1. Chemical Composition

The chemical composition of each lot of bayonets is given in Table I. In the case of Lot I which was manufactured by Springfield Armory, chemical analyses were made of bayonets representing each of the twelve years of manufacture submitted. It was found that the bayonets submitted by four of the six commercial companies, Lots A, B, C, D, F, and G, were made from WD-1080 steel; whereas the bayonets submitted by the other two companies were made from WD-5090 steel, Lots E and H. The bayonets manufactured by Springfield Armory (Lot I) in the years 1906 to 1915 were found to range in carbon content from .75 to 1.40% and all were made of plain carbon steel with the exception of those manufactured in 1913, 1914, and 1915. The 1913 and 1915 bay-

* The critical section referred to in this report is the section immediately to the rear of the bolster where breakages in the tang have been reported.

onets were made of modified WD 1080 steels containing .38% tungsten and .83% nickel respectively, whereas the 1914 bayonet was made of a modified WD 5095 steel containing .55% nickel.

The maximum section sizes of both the M1905 and M1 bayonets are such that the use of alloying elements is unnecessary to insure adequate hardenability after oil quenching. WD-1080 steel corresponds to the eutectoid composition for plain carbon steels and is known to possess greater potential hardenability than steels of higher or lower carbon content. As compared with steels of higher carbon content, WD-1080 would be expected to possess greater potential toughness but less ability to maintain keenness of cutting edge. As compared with steels of lower carbon content, WD 1080 steel would be expected to possess less potential toughness but greater ability to maintain keenness of cutting edge. On the basis of conservation of strategic elements and considerations of the properties desired in bayonets, WD 1080 steel would appear to be the optimum composition for this application.

II. Hardness Surveys

The results of the hardness surveys are given in Appendix A. These results are summarized in Table II which lists the general hardness level of the tang, the average hardness at the critical section, the limits of hardness transition zones, and the general hardness level of the maximum hardened portion of the blades of bayonets representing each lot. Detailed results of the hardness surveys follow:

A. General Hardness Level of Tang

As shown in Table II, only three of the eight lots of commercially manufactured bayonets possess hardened tangs. The general hardness levels of the hardened tangs are Rockwell "C" 47-51, 37-39, and 49-50 in the case of Lots A, C, & F respectively. The other five lots of commercially manufactured bayonets possess unhardened tangs varying from Rockwell "C" -9 to 23. In the case of the bayonets representing 12 years of Springfield Armory manufacture, the general hardness level of the tangs varies from Rockwell "C" 3 to 30. Bayonets manufactured in 1908, 1909, 1911, and 1912 possess tangs of the highest hardness level (Rockwell "C" 27-30) whereas the level of all the other years of Springfield Armory manufacture is Rockwell "C" 21 or lower.

B. Average Hardness of Critical Section

The average hardness at the critical section of four bayonets of each lot of commercial manufacture and of one bayonet of each of the 12 years of Springfield Armory manufacture is given in Table II. The general hardness level of the tang is equivalent to the average hardness of the critical section in the case of each of the nine lots with the exceptions of Lots C and D. In the case of Lot C, the critical section is in the hardness transition zone, whereas in the case of Lot D, the critical section is in the maximum hardened portion of three of the four bayonets tested.

C. Hardness Transition Zones

The hardness transition zones consist for the most part of lengths of the bayonets over which the hardness increases uniformly on going from the tang to the maximum hardened portion of the blade. The limits of the transition zones vary from lot to lot and even in the same lot. Considered as a whole, the limits of the transition zones for all nine lots are 1-1/4" from the guard in the direction of the pommel and 3" from the guard in the direction of the point. In the case of the bayonets of Lots A and F which possess hardened tangs, the hardness decreases to a minimum of Rockwell "C" 37-40 and 23-25 respectively instead of remaining uniform throughout. In the case of the bayonets of Lot C which possess hardened tangs which are somewhat softer than the maximum hardened portions of the blades, the hardness decreases to a minimum of Rockwell "C" 11-26 at the front of the guard instead of increasing uniformly on going from the tang to the blade.

D. Hardness Level of Blade

The hardness level of the maximum hardened portion of blades representing each lot is within the range of Rockwell "C" 43 - 55. This range overlaps the hardness range of Rockwell "C" 46-52 stipulated for bayonet blades in U.S. Army Spec. No. 57-108-B.

III. Microexamination

A. Critical Section

The microstructures at the critical sections of bayonets representing each of the nine lots are shown in Figures 2 -A- to -T-. A summary of the condition and hardness of the critical sections is given in Table III. It was found that the microstructures of Lots A, C, D & F consist primarily of tempered martensite, indicating a quench and temper treatment. The microstructures of the five remaining lots vary from spheroidized cementite (or alloy carbides) to predominantly pearlite, indicating for the most part variations in the annealing treatment. In the case of Lots E, I 1909, I 1912, and I 1917, the presence of a cementite network was detected at the grain boundaries, indicating a slow rate of cooling from the forging heat. Traces of grain boundary cementite together with a coarse pearlite structure were found in the case of Lot B, which may be the result of too high an annealing temperature. The fineness of the pearlite and the hardness of Lots I 1908, I 1909, I 1911, and I 1912 indicate that these particular bayonets were not annealed after forging. Evidence of cold working was found in the Lot I 1908 bayonet, indicating that forging was finished at too low a temperature.

B. Maximum Hardened Portion of Blade

The microstructures and hardness of the maximum hardened portion of representative bayonet blades of each lot are shown in Table IV.

The microstructures consist for the most part of tempered martensite, indicating a quench and temper treatment. However, such microstructural constituents as undissolved carbides, undissolved or partially dissolved pearlite areas, and pearlite ghosts (partially dissolved cementite in lamellar form) were found and indicate that most of the bayonets were insufficiently heated prior to quenching. The presence of primary troostite was found in most cases and indicates a slow rate of quenching although to some extent insufficient heating may have resulted in lowered hardenability. In cases where undissolved carbides and/or pearlite ghosts were found without any primary troostite in the structure, the heat treatment was judged passable but was not considered to have resulted in the most desirable condition. The most desirable condition is believed to be a substantially homogeneous microstructure consisting of tempered martensite.* The presence of grain boundary carbides was detected in Bayonets Lot I 9, I 14, I 15, and I 18 although not in most of the bayonets which were found to possess this condition at the critical section. This indicates that solution of the carbide network can occur to some extent during the heating for hardening. The decarburization found on the sides of Bayonets Lots C 1, G 1, and H 1 probably resulted from previous forging or annealing treatments and was not removed by machining prior to hardening.

C. Supplementary Microexamination

In order to determine the reason for variations in the results of hardness surveys of the four bayonets of Lots A, B, C, D, and F given in Appendix A, microexamination was made of selected positions in these bayonets. The results of this supplementary microexamination is summarized in Table V which also includes the hardness values of the positions examined. Photomicrographs of these structures are shown in Figures 2 -U- to -Z1- and their significance is as follows:

(1) Lot A - The structure near the pommel of Bayonet No. 1 consists of tempered martensite with little or no primary troostite as shown in Figure 2 -U-. This accounts for the higher hardness near the pommel than in the region between the critical section and guard where the structure consists of areas of primary troostite at the grain boundaries, pearlite ghosts, and tempered martensite as shown in Figure 2 -A-. It appears that the means used to support the bayonet prevented this region from attaining the temperature of the heating bath.

(2) Lot B - The structure of the critical sections of three of the bayonets of this lot varies from coarse pearlite to spheroidized pearlite as shown in Figures 2 -B-, -V-, and -W-. These variations indicate that the bayonets of this lot did not receive a uniform annealing treatment.

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* WAL Report No. 320/29

(3) Lot C - The structure near the pommel of Bayonet No. 1 is shown in Figure 2 -X- and consists of tempered martensite and numerous small areas of primary troostite. The presence of more primary troostite in the tang near the pommel than at the critical section (see Figure 2 -C-) accounts for the lower hardness near the pommel. The presence of troostite in the tang indicates a slower rate of quenching than was attained in the hardened portion of the blade.

The structure at the front of the guard of Bayonet No. 4 consists of areas of pearlite and primary troostite as shown in Figure 2 -Y-. This structure accounts for the hardness decrease which was found at the front of the guard of Bayonets No. 2 and 4. Evidently, the region at the front of the guard was prevented from attaining the temperature of the heating bath by the means used to support the bayonets.

(4) Lot D - The structure at the critical section of Bayonet No. 2 of this lot consists of spheroidized cementite with traces of pearlite as shown in Figure 2 -Z-. The tang of this bayonet is in the unhardened condition whereas the tangs of the other three bayonets of this lot were hardened starting at a point about 1" from the front of the guard. This indicated that bayonets of this lot were not immersed to the same depth in the bath used for heating.

(5) Lot E - The structure at a point 3/4" from the front of the guard in the direction of the blade point of Bayonet No. 1 is shown in Figure 2 -Z- and consists of spheroidized cementite in a ferritic matrix which shows some evidence of cementite solution. This structure accounts for the decrease in hardness which occurred at this location in all four bayonets of this lot that were tested. Evidently, a region about 2" long of the portion of the blade near the front of the guard did not attain the temperature of the bath used for heating. It is believed that the means used to support these bayonets during heating was responsible for this condition.

IV. Discussion of Results

The results of this examination reveal that variations in forging, annealing, hardening, and tempering treatment as well as in composition exist among the nine lots of bayonets submitted. From the standpoint of conservation of strategic elements, adequate hardenability, potential toughness, and ability to retain keenness of cutting edge after heat treatment, the WD-1080 steel is considered the best steel to use for bayonets.

The occurrence of carbide network at the grain boundaries of bayonets is considered detrimental to their toughness and may possible account for the breakages which have occurred at the critical section. In order to prevent the formation of such a network, it is important that nothing interfere with the normal rate of air cooling of bayonets from the forging temperature. A slow rate of cooling leading to the formation of carbide network can occur if the bayonets are stacked together right after forging. If such a network does result, it can be eliminated by a normalizing treatment prior to annealing. A carbide network can also result from too high an annealing temperature.*

The structure and hardness resulting from annealing depends on the temperature, time, and rate of cooling. High annealing temperatures, long times at temperature, and relatively fast rates of cooling are conducive to the formation of pearlite; whereas low annealing temperatures, short times at temperature, and relatively slow or even interrupted cooling is conducive to spheroidized structures. By proper control of the above mentioned variables, almost any combination of pearlite and spheroidized carbides may be obtained. From the standpoint of machineability, it is generally desirable that the annealed structure be composed of not more than 25% of pearlite areas. The size of the spheroidized carbides should preferably be small so that they will not be likely to impair machineability and so that they will dissolve readily in heating for hardening. The practice of eliminating the annealing treatment and machining bayonets in the as-forged condition is not to be recommended because of the added machining difficulties due to increased hardness and non-uniformity of microstructure.

The annealed structures which were found in the bayonets examined varied from a condition of complete spheroidization to all pearlite, corresponding to a variation in hardness of -9 to 23 Rockwell "C". This variation in hardness corresponds to a variation of tensile strength from about 70,000 to 120,000 psi. Therefore, if the tangs of bayonets are not to be hardened, it would appear desirable from the standpoint of strength to aim for a pearlite rather than a spheroidized structure after annealing. However, by hardening the tangs as well as the blades of bayonets, it is possible to take advantage of the machining qualities of a spheroidized structure and at the same time increase the strength of the tang considerably above that obtainable by an annealing treatment which results in all pearlite.

High strength is desirable in the tangs of bayonets from the standpoint of preventing the occurrence of bending in service. If high strength is brought about by proper heat treatment, it is believed that the resulting toughness will be adequate to insure satisfactory performance. It is important, however, that carbide network at the grain boundaries resulting from the annealing treatment be avoided since this condition cannot always be eliminated by the heating for hardening and lowered toughness will result.

The use of a lead or salt heating bath is well suited to the production hardening of bayonets both from the standpoint of fast heating and freedom from scale and decarburization. The temperature of the

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* In both the forging and annealing treatments, care should be taken to prevent excessive decarburization since this condition is of course detrimental to the cutting edge of bayonet blades.

heating bath and the time of heating should be so chosen to allow the bayonets to develop adequate hardenability on quenching. Too low a heating bath temperature or too short a heating time may result in soft spots (troostite areas) or may even result in failure to harden. Too high a heating bath temperature or too long a heating time may result in grain growth which is detrimental to toughness. A heating temperature in the range of about 1500 to 1600°F and a heating time of about 6 minutes is recommend; however, the optimum temperature and time will depend on such factors as the number of bayonets hardened at one time and whether lead or salt is used as the heating bath. Oil is preferred to water as the quenching medium since less cracking and distortion results from oil quenching.

In hardening bayonets from the blade point to the pommel, production difficulties may interfere with attaining a uniform hardness throughout. The means of supporting bayonets in the heating bath may prevent parts of these bayonets from attaining the desired temperature prior to quenching. Likewise, the means of support may also interfere with uniform quenching of bayonets. The time between removal of the tangs from the heating bath and insertion in the quenching tank may be too long to permit the attainment of full hardening in the tangs. All of these factors must be considered in order to insure uniform hardening. In addition, care should be taken to maintain the quenching oil at or near room temperature.

The tempering treatment considered desirable for uniformly hardened bayonets should be such as to result in a uniform hardness in the range of Rockwell "C" 46 to 52. This hardness range has been found the optimum for bayonet blades from the standpoint of impact strength and meeting the bend test requirements of U.S. Army Specification No. 57-4-1B*. This hardness range is considered satisfactory for bayonet tangs since transverse bend tests of WD-1080 bayonet steel have revealed that below a hardness of Rockwell "C" 51-52 bending rather than breakage occurs at maximum load. (See Appendix B). A uniform hardness in the range of Rockwell "C" 46 to 52 can be obtained by tempering the entire bayonet for 2 hours at a temperature in the range of 550 to 750°F.

* WAL Report No. 320/29

TABLE I

CHEMICAL COMPOSITION

LOT	MANUFACTURER	YEAR OF MFG.	STEEL	C	MN	SI	S	P	NI	CR	W
A	Pal Blade Co.	1943*	WD 1080	.81	.79	.13	.035	.023	Nil	.01	----
B	Pal Blade Co.	1943*	WD 1080	.83	.79	.27	.030	.012	Nil	.01	----
C	Pal Blade Co.	1943*	WD 1080	.83	.81	.17	.036	.019	Nil	.015	----
D	American Fork & Hoe Co.	1943*	WD 1080	.83	.58	.23	.035	.020	.52	.03	----
E	Utica Cutlery Company	1942	WD 5090	.85	.52	.30	.024	.020	.20	.50	----
F	Union Fork & Hoe Co.	1943*	WD 1080	.87	.54	.26	.032	.017	Trace	.025	----
G	Oneida Ltd.	1943	WD 1080	.79	.65	.21	.027	.015	Nil	.02	----
H	Wilde Drop & Forge Mfg. Company	1943	WD 5090	.89	.35	.27	.021	.015	Nil	.48	----
I	Springfield Armory	1906	WD 10110	1.13	.46	.21	.034	.042	Trace	.01	----
I	Springfield Armory	1907	WD 10100	1.08	.26	.28	.019	.011	Nil	.01	.02
I	Springfield Armory	1908	WD 1095	.94	.35	.15	.031	----	Nil	.01	----
I	Springfield Armory	1909	WD 10140	1.41	.40	.16	.026	.018	Nil	.01	----
I	Springfield Armory	1911	WD 1095	.88	.38	.14	.029	.011	Nil	.01	----
I	Springfield Armory	1912	WD 10110	1.11	.41	.08	.029	.011	Nil	.01	----
I	Springfield Armory	1913	Modified WD 1080	.75	.36	.21	.016	.012	Trace	.10	.38
I	Springfield Armory	1914	Modified WD 5095	1.03	.30	.11	.047	.008	.55	.40	----
I	Springfield Armory	1915	Modified WD 1080	.87	.40	.17	.041	.014	.83	.12	----
I	Springfield Armory	1916	WD 1095	1.03	.44	.16	.033	.017	Trace	.06	----
I	Springfield Armory	1917	WD 10100	1.06	.44	.16	.032	.016	Trace	.01	----
I	Springfield Armory	1918	WD 10100	1.08	.22	.30	.017	----	Trace	.07	.08

* Year of manufacture was not stamped on bayonets but probably is 1943.

TABLE II

RESULTS OF HARDNESS SURVEYS

LOT	MANUFACTURER	TYPE OF BAY-ONET	YEAR OF MFG.	NUMBER OF BLADES TESTED	ROCKWELL "C" HARD-NESS LEV-EL OF TANG	AVERAGE ROCK-WELL "C" HARDNESS AT CRIT-ICAL SECTION	LOCATION OF TRANSITIONAL ZONE AS MEAS-URED FROM FRONT OF GUARD IN INCHES.**	ROCK-WELL "C" HARD-NESS LEVEL OF BLADE
A	Pal Blade Co.	M1	1943*	4	47 to 51	47	-1 to +1/4	48-50
B	Pal Blade Co.	M1	1943*	4	-9 to 6	1	-3/4 to +2	50-54
C	Pal Blade Co.	M1	1943*	4	37 to 39	44	-1 to +1-1/4	49-51
D	American Fork & Hoe Co.	M1	1943*	4	-6 to -2	-2 to 51	-1-1/4 to +1	52-53
E	Utica Cutlery Company	M1	1942	4	10 to 23	18	+1/2 to +1-1/2	47-55
F	Union Fork & Hoe Co.	M1	1943*	4	49 to 50	50	-1/2 to +2-1/4	49-51
G	Oneida Ltd.	M1	1943	4	-5 to 2	0	-1/4 to +1-3/4	49-51
H	Wilde Drop & Forge Mfg. Co.	M1905	1943	4	2 to 13	8	-1/2 to +3/4	53-55
I	Springfield Armory	M1905	1906	1	21	16	-1/2 to +1-1/4	52
I	Springfield Armory	M1905	1907	1	21	17	-1/4 to +3	48
I	Springfield Armory	"	1908	1	29	26	-1/4 to +2	52
I	Springfield Armory	"	1909	1	28	23	-1/4 to +1-1/4	43
I	Springfield Armory	"	1911	1	27	25	-1/2 to +1-3/4	52
I	Springfield Armory	"	1912	1	30	29	-1/2 to +2	51
I	Springfield Armory	"	1913	1	16	16	+3/4 to +1-3/4	52
I	Springfield Armory	"	1914	1	15	16	-1/4 to +1-3/4	51
I	Springfield Armory	"	1915	1	17	13	+1/2 to +2	50
I	Springfield Armory	"	1916	1	3	3	0 to +2	45
I	Springfield Armory	"	1917	1	13	12	3/4 to 1-3/4	47
I	Springfield Armory	"	1918	1	17	13	0 to 1-1/4	47

* Year of manufacture was not stamped on bayonet but probably is 1943.
** Direction of blade point is positive; direction of pommel is negative.

TABLE III

SUMMARY OF RESULTS OF MICROEXAMINATION OF CRITICAL SECTIONS OF BAYONETS

LOT	NO.	MANUFACTURER	TYPE OF BAYONETS	YEAR OF MANU-FACTURE	CONDITION	FIGURE NUMBER	ROCKWELL "C" HARDNESS
A	1	Pal Blade Co.	M1	1943*	Slowly quenched and tempered	2 -A-	47
B	1	Pal Blade Co.	M1	1943*	Annealed	2 -B-	4
C	1	Pal Blade Co.	M1	1943*	Slowly quenched and drawn	2 -C-	46
D	1	American Fork and Hoe Co.	M1	1943*	Slowly quenched and drawn	2 -D-	40
E	1	Utica Cutlery Company	M1	1942	Annealed	2 -E-	22
F	1	Union Fork and Hoe Company	M1	1943*	Quenched and Tempered	2 -F-	50
G	1	Oneida Ltd.	M1	1943	Spheroidize-Annealed	2 -G-	3.5
H	1	Wilde Drop Forge Mfg. Co.	M1905	1943	Spheroidized	2 -H-	3.5
I	6	Springfield Armory	M1905	1906	Spheroidize-Annealed	2 -I-	16
I	7	Springfield Armory	M1905	1907	Spheroidize-Annealed	2 -J-	17
I	8	Springfield Armory	"	1908	Forged to too low a temperature	2 -K-	26
I	9	Springfield Armory	"	1909	Forged	2 -L-	23
I	11	Springfield Armory	"	1911	Forged	2 -M-	25
I	12	Springfield Armory	"	1912	Forged	2 -N-	29
I	13	Springfield Armory	"	1913	Annealed	2 -O-	16
I	14	Springfield Armory	"	1914	Spheroidize-Annealed	2 -P-	16
I	15	Springfield Armory	"	1915	Annealed	2 -Q-	13
I	16	Springfield Armory	"	1916	Spheroidize-Annealed	2 -R-	3
I	17	Springfield Armory	"	1917	Annealed	2 -S-	12
I	18	Springfield Armory	"	1918	Spheroidize-Annealed	2 -T-	13

* Year of manufacture was not stamped on bayonets but probably is 1943.

TABLE IV

SUMMARY OF RESULTS OF MICROEXAMINATION OF MAXIMUM HARDENED PORTION

OF BAYONET BLADES

LOT	NO.	MANUFACTURER	TYPE OF BAYONET	YEAR OF MFG.	MICROSTRUCTURE	ROCKWELL "C" HARDNESS	REMARKS
A	1	Pal Blade Co.	M1	1943*	Tempered martensite. Areas of primary troostite, and pearlite ghosts at center.	50	Insufficient heating and slow rate of quenching.
B	1	Pal Blade Co.	M1	1943*	Tempered martensite. Pearlite ghosts at center.	54	Passable heat treatment.
C	1	Pal Blade Co.	M1	1943*	Tempered martensite. Pearlite ghosts at center. Both sides carburized 0.011 to 0.017".	50	Passable heat treatment.
D	1	American Fork and Hoe Co.	M1	1943*	Tempered martensite. Primary troostite areas. Undissolved carbides.	53	Insufficient heating and slow rate of quenching.
E	1	Utica Cutlery Company	M1	1942	Tempered martensite. Pearlite ghosts at center.	48	Passable heat treatment.
F	1	Union Fork & Hoe Co.	M1	1943*	Tempered martensite. Undissolved carbides.	51	Passable heat treatment.
G	1	Oneida Ltd.	M1	1943	Tempered martensite. Small primary troostite areas. Pearlite ghosts. One side decarburized .001".	50	Insufficient heating and slow rate of quenching.
H	1	Wilde Drop Forge & Mfg. Company	M1905	1943	Tempered martensite. Undissolved carbides. Both sides decarburized .005".	53	Passable heat treatment.
I	6	Springfield Armory	M1905	1906	Tempered martensite. Small primary troostite areas. Undissolved carbides.	52	Insufficient heating and slow rate of quenching.

TABLE IV (CONT'D)

SUMMARY OF RESULTS OF MICROEXAMINATION OF MAXIMUM HARDENED PORTION OF

BAYONET BLADES

LOT	NO.	MANUFACTURER	TYPE OF BAYONET	YEAR OF MFG.	MICROSTRUCTURE	ROCKWELL "C" HARDNESS	REMARKS
I	7	Springfield Armory	M1905	1907	Tempered martensite and small areas of primary troostite at outside. Primary troostite and areas of partially dissolved pearlite and undissolved carbides at center.	47	Insufficient heating and slow rate of quenching.
I	8	Springfield Armory	M1905	1908	Tempered martensite. Primary troostite. Undissolved carbides both within grains and at grain boundaries.	52	Insufficient heating and slow rate of quenching.
I	9	Springfield Armory	"	1909	Primary troostite. Partially dissolved pearlite areas. Undissolved carbides.	43	Insufficient heating and very slow rate of quenching.
I	11	Springfield Armory	"	1911	Tempered martensite. Primary troostite. Pearlite ghosts.	52	Insufficient heating and slow rate of quenching.
I	12	Springfield Armory	"	1912	Tempered martensite	51	Satisfactory heat treatment.
I	13	Springfield Armory	"	1913	Tempered martensite. Pearlite ghosts.	52	Passable heat treatment.

TABLE IV (CONT'D)

SUMMARY OF RESULTS OF MICROEXAMINATION OF MAXIMUM HARDENED PORTION OF BAYONET BLADES

LOT NO.	MANUFACTURER	TYPE OF BAYONET	YEAR OF MFG.	MICROSTRUCTURE	ROCKWELL "C" HARDNESS	REMARKS
I 14	Springfield Armory	M1905	1914	Tempered martensite. Undissolved carbides. Grain boundaries carbides and pearlite ghosts at center.	51	Passable heat treatment. Poor grain boundary condition.
I 15	Springfield Armory	"	1915	Tempered martensite. Pearlite ghosts. Partially dissolved pearlite areas. Undissolved carbides both within grains and at boundaries at center.	49	Insufficient heating. Poor grain boundary condition.
I 16	Springfield Armory	"	1916	Tempered martensite, Primary troostite, and undissolved carbides at outside. Pearlite ghosts. Undissolved carbides and areas of spheroidized pearlite at center.	45	Insufficient heating and slow quenching rate.
I 17	Springfield Armory	"	1917	Tempered martensite. Undissolved carbides and pearlite areas at center.	47	Insufficient heating.
I 18	Springfield Armory	"	1918	Tempered martensite. Partially dissolved pearlite areas. Undissolved carbides within grains and at boundaries.	52	Insufficient heating. Poor grain boundary condition.

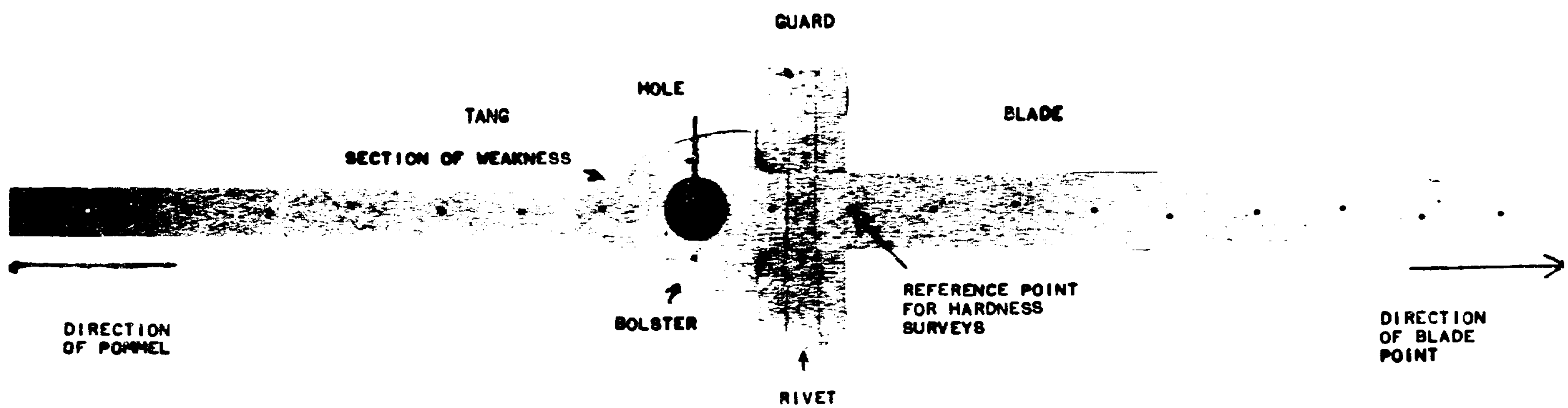
* Year of manufacture was not stamped on bayonet but probably is 1943.

TABLE V

SUMMARY OF RESULTS OF SUPPLEMENTARY MICROEXAMINATION

LOT	NO.	MANUFACTURER	TYPE OF BAYONET	YEAR OF MFG.	PART OF BAYONET	DISTANCE FROM FRONT OF GUARD IN INCHES	CONDITION	FIGURE NUMBER	ROCKWELL "C" HARDNESS
A	1	Pal Blade Co.	M1	1943*	Tang	-2-3/4	Quenched and drawn	2-U-	51
B	3	Pal Blade Co.	M1	1943*	Critical Section	-3/4	Spheroidized	2-V-	-11
B	4	Pal Blade Co.	M1	1943*	Critical Section	-3/4	Spheroidize-Annealed	2-W-	9
C	1	Pal Blade Co.	M1	1943*	Tang	-2-3/4	Slowly quenched and drawn	2-X-	38
C	4	Pal Blade Co.	M1	1943*	Front of Guard	0	Partially hardened. This part of bayonet did not attain temperature of heating bath.	2-Y-	26
D	2	American Fork and Hoe Co.	M1	1943*	Critical Section	-3/4	Spheroidize-Annealed	2-Z-	-2
F	1	Union Fork and Hoe Co.	M1	1943*	Blade	+3/4	Spheroidized This part of bayonet did not attain temperature of heating bath.	2-Z1-	25

* Year of manufacture was not stamped on bayonets but probably is 1943.
** Direction of blade point is positive; direction of pommel is negative.



WATERTOWN ARSENAL

FIGURE 1

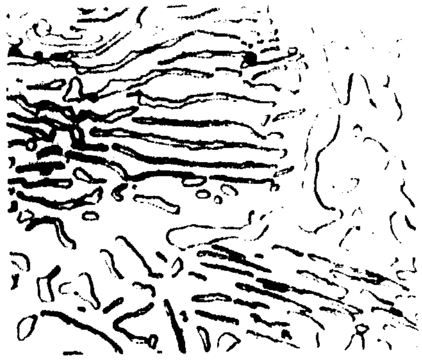
LONGITUDINAL SECTION OF BAYONET IN VICINITY OF GUARD SHOWING HARDNESS SURVEY. ROCKWELL "C" HARDNESS READINGS WERE TAKEN 1/4" APART STARTING AT A REFERENCE POINT IN LINE WITH THE SIDE OF THE GUARD NEAREST THE BLADE POINT.
MAGNIFICATION X 2
3 JAN 1944
WTN.693-60

FIG. 1

-A-

LOT A — CRITICAL SECTION

TEMPERED MARTENSITE. GRAIN BOUNDARY PRIMARY TROOSTITE AREAS. PEARLITE GHOSTS.



-B-

LOT B — CRITICAL SECTION

COARSE PEARLITE. TRACES OF GRAIN BOUNDARY CEMENTITE. BAYONET NO. 1.

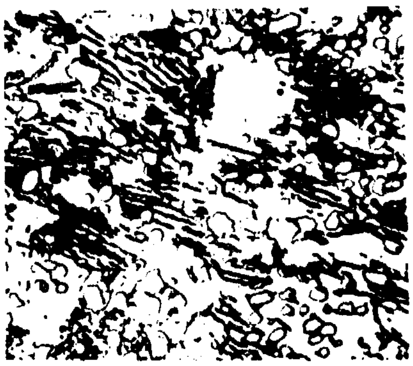
-C-

LOT C — CRITICAL SE

TEMPERED MARTENSITE SCATTERED PRIMARY TROOSTITE AREAS. BAYONET NO. 1.

LOT D — CRI

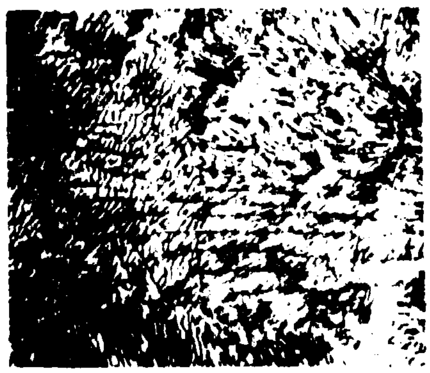
TEMPERED MA
TROOSTITE A
CEMENTITE.



-J-

LOT I 1907 — CRITICAL SECTION.

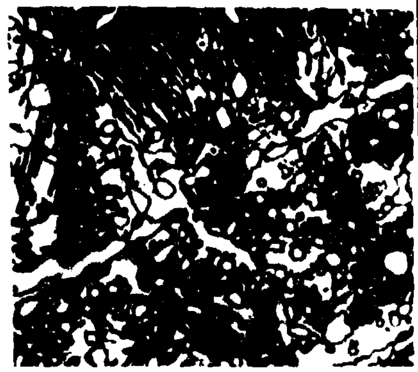
PEARLITE. SPHEROIDIZED CEMENTITE. SMALL FERRITE AREAS.



-K-

LOT I 1908 — CRITICAL SECTION.

PEARLITE. EVIDENCE OF COLD WORK.



-L-

LOT I 1909 — CRITICAL SECTION.

PEARLITE. SPHEROIDIZED CEMENTITE. GRAIN BOUNDARY CEMENTITE.

LOT I 1911
SECTION.

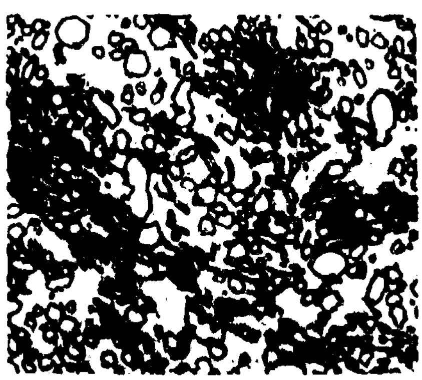
FINE PEARLI
FERRITE.

WTN.639-6289

-S-

LOT I 1917 — CRITICAL SECTION.

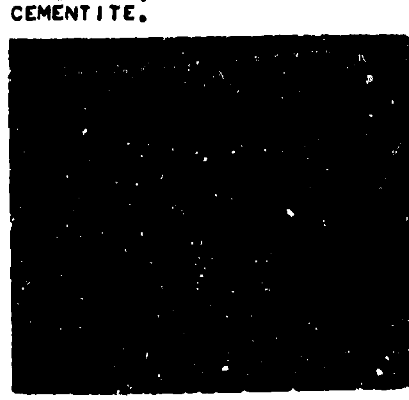
COARSE PEARLITE. GRAIN BOUNDARY CEMENTITE.



-T-

LOT I 1918 — CRITICAL SECTION.

PEARLITE. SPHEROIDIZED CEMENTITE.



-U-

LOT A — NEAR POMMEL

TEMPERED MARTENSITE. BAYONET NO. 1.

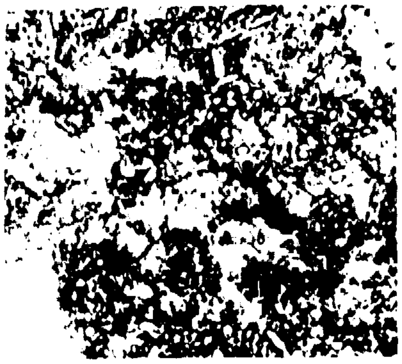
LOT B — CR

SPHEROIDIZED
BAYONET NO.

WTN.639-62

MAGNI

FIGURE 2—PHOTOMICROGRAPHS OF BAYO



-D-

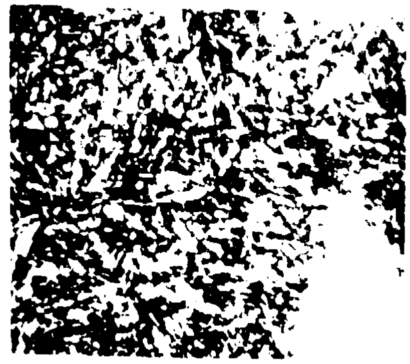
CRITICAL SECTION

D MARTENSITE. PRIMARY
ITE AREAS. UNDISSOLVED
ITE. BAYONET NO. 1.

-E-

LOT E – CRITICAL SECTION

PEARLITE. GRAIN BOUNDARY
CARBIDES. BAYONET NO. 1



-F-

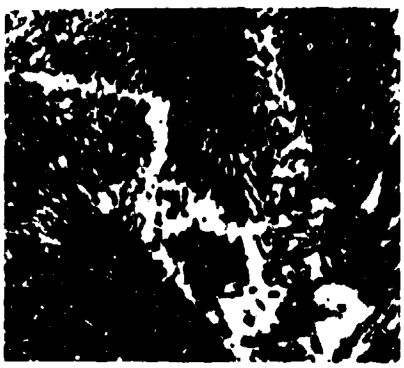
LOT F – CRITICAL SE

TEMPERED MARTENSITE.
FERRITE IN CRYSTALLOGR
IC PLANES. BAYONET NO.

-G-

LOT G – CRITICAL SE

SPHEROIDZED CEMENTITE
OF PEARLITE. BAYONET N



-M-

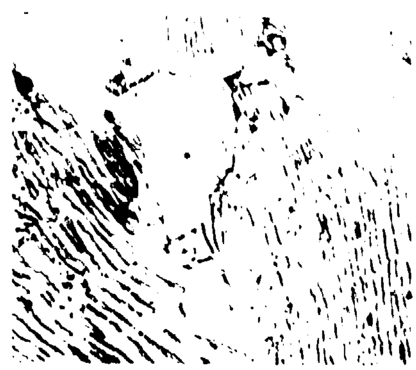
LOT I 1911 – CRITICAL
SECTION.

FINE PEARLITE.GRAIN BOUNDARY
FERRITE.

-N-

LOT I 1912 – CRITICAL
SECTION.

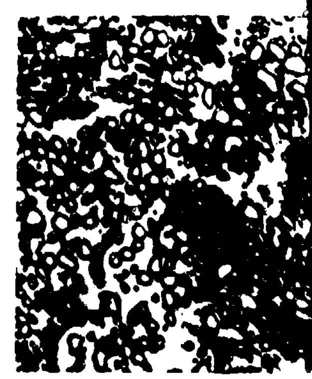
COARSE AND FINE PEARLITE.
GRAIN BOUNDARY CEMENTITE.



-O-

LOT I 1913 – CRITICAL
SECTION.

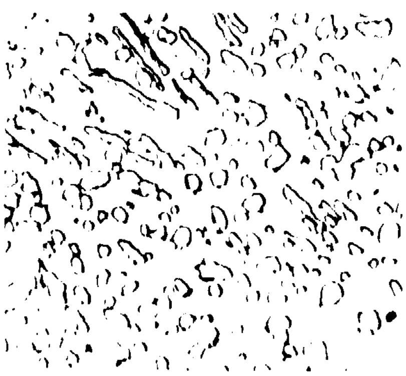
PEARLITE. SMALL AMOUNT OF
FERRITE.



-P-

LOT I 1914 – CRITICAL

SPHEROIDIZED CARBIDES
TRACES OF PEARLITE.

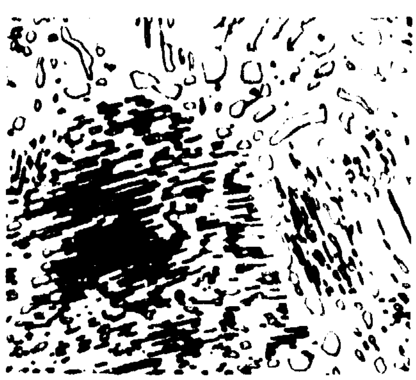


-V-

LOT B – CRITICAL SECTION

SPHEROIDIZED CEMENTITE.
BAYONET NO. 3.

WTN.639-6290



-W-

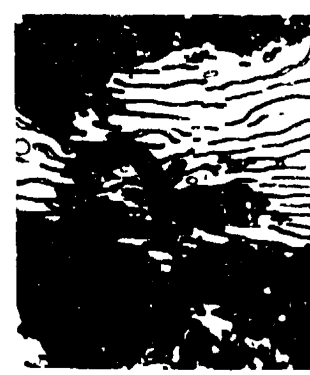
LOT B – CRITICAL SECTION

SPHEROIDIZED CEMENTITE.
AREAS OF PEARLITE.
BAYONET NO. 4.

-X-

LOT C – NEAR POMMEL

TEMPERED MARTENSITE.
NUMEROUS SMALL AREAS OF
PRIMARY TROOSTITE. BAYON
NO. 1.



-Y-

LOT C– FRONT OF GUARD

PEARLITE. PRIMARY TROO
AREAS. PEARLITE GHOSTS
BAYONET NO. 4.

WTN.639-6291

MAGNIFICATION–1500X

ETCH–PICRAL

BAYONETS OF COMMERCIAL AND SPRING FIELD ARM

-

AL SECTION

NSITE. SOME
STALLOGRAPH-
YONET NO. I.

-G-

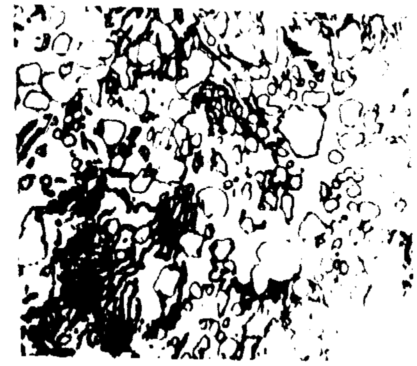
·ITICAL SECTION

·MENTITE. TRACES
·AYONET NO. I.

-H-

LOT H — CRITICAL SECTION

SPHEROIDIZED CARBIDES.
BAYONET NO. I.



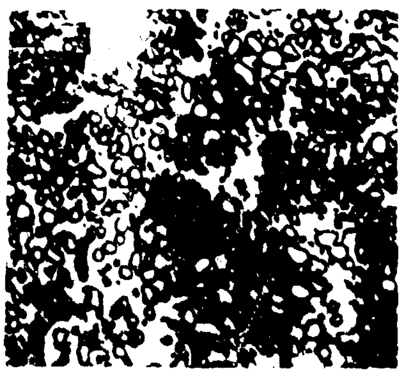
-I-

LOT I 1906 — CRITI·A

SPHEROIDIZED CEMENTI·
MARKED TRACES OF PEA·

CRITICAL

·L AMOUNT OF



-P-

LOT I 1914 — CRITICAL SECTION

SPHEROIDIZED CARBIDES. MARKED
TRACES OF PEARLITE.

-Q-

LOT I 1915 — CRITICAL SECTION

PEARLITE.

-R-

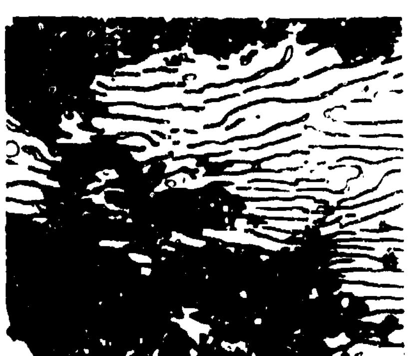
LOT I 1916 — CRITICAL SECTI·

SPHEROIDIZED CEMENTITE.
MARKED TRACES OF PEARLITE.

·-

·POMMEL

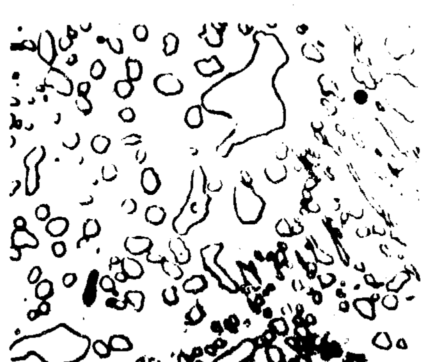
·ITE.
·REAS OF
E. BAYONET



-Y-

LOT C- ·RONT OF GUARD

PEARL· · PRIMARY TROOSTITE
AREA· ·ARLITE GHOSTS.
·· ·. 4.



-Z-

LOT D — CRITICAL SECTION

SHPEROIDIZED CEMENTITE.
TRACES OF PEARLITE.
BAYONET NO. 2.

-Z1-

LOT F — 3/4" FROM GUARD
TOWARD POINT.

SPHEROIDIZED CEMENTITE.
EVIDENCE OF CEMENTITE
SOLUTION IN FERRITE MATRIX.
BAYONET NO. I.

·ICRAL

·PRING

·) ARMORY MANUFACTURE—FIG. 2

APPENDIX A

ROCKWELL "C" HARDNESS SURVEYS OF NINE LOTS OF BAYONETS

LOT NO.		MFR.	BAYONET TYPE	YEAR OF MFG.	DISTANCE ** FROM FRONT OF GUARD IN INCHES																
					-2½	-2	-1½	-1	-3/4	-½	-1/4	0	+1/4	+½	+3/4	+1	+1¼	+1½	+2	+3	+4
A	1	Pal Blade Company	M1	1943*	50	51	50	51	49	40	39	47	50	50	50	49	49	49	48	49	50
	2	Pal Blade Company	"	"	50	50	51	51	44	39	37	40	49	50	50	50	50	50	50	50	50
	3	Pal Blade Company	"	"	47	46	47	48	47	45	45	45	46	47	46	46	47	46	47	48	48
	4	Pal Blade Company	"	"	50	50	48	49	48	45	40	46	49	49	49	49	47	49	4[illegible]	50	50
B	1	Pal Blade Company	"	"	3	4	5	3	4	2	4	5	27	38	51	52	52	52	53	54	54
	2	Pal Blade Company	"	"	6	7	6	1	3	23	33	39	48	49	49	49	50	49	49	50	50
	3	Pal Blade Company	"	"	-8	-12	-8	-7	-11	-8	-10	-9	25	32	37	49	49	51	50	51	51
	4	Pal Blade Company	"	"	4	4	7	6	9	4	4	6	8	6	33	37	38	45	50	50	51
C	1	Pal Blade Company	"	"	38	37	37	41	46	49	50	50	50	49	50	49	51	50	50	50	50
	2	Pal Blade Company	"	"	37	38	38	39	40	40	40	11	32	38	43	47	49	49	50	49	49
	3	Pal Blade Company	"	"	37	36	38	40	48	51	51	52	52	49	51	50	50	51	51	51	50
	4	Pal Blade Company	"	"	38	37	38	36	40	40	41	26	33	38	46	47	45	47	46	48	49

APPENDIX A (CONT'D)

ROCKWELL "C" HARDNESS SURVEYS OF NINE LOTS OF BAYONETS

LOT	NO.	MFR.	BAYONET TYPE	YEAR OF MFG.	DISTANCE ** FROM FRONT OF GUARD IN INCHES: $-2\frac{1}{2}$	-2	$-1\frac{1}{2}$	-1	$-3/4$	$-\frac{1}{2}$	$-1/4$	0	$+1/4$	$+\frac{1}{2}$	$+3/4$	$+1$	$+1\text{-}1/4$	$+1\frac{1}{2}$	$+2$	$+3$	$+4$
D	1	American Fork & Hoe Co.	M1	1943*	-1	-4	-2	0	40	51	50	52	52	53	52	53	53	53	53	52	53
	2	American Fork & Hoe Co.	"	"	-1	-2	-1	-2	-2	-7	-1	0	1	37	44	51	52	52	52	53	52
	3	American Fork & Hoe Co.	"	"	-6	-7	-5	14	51	52	49	53	51	51	51	52	53	53	52	53	52
	4	American Fork & Hoe Co.	"	"	-5	-4	-8	-2	49	52	52	53	50	51	50	51	52	51	51	51	52
E	1	Utica Cutlery Company	"	1942	23	23	21	21	22	18	22	23	24	22	22	45	47	46	47	47	48
	2	Utica Cutlery Company	"	"	20	21	19	20	18	18	18	21	22	39	46	50	52	52	52	53	52
	3	Utica Cutlery Company	"	"	11	8	12	12	11	10	11	12	14	12	41	53	54	54	53	55	55
	4	Utica Cutlery Company	"	"	18	18	19	18	18	16	17	17	18	18	18	35	45	46	46	46	47

APPENDIX A (CONT'D)

ROCKWELL "C" HARDNESS SURVEYS OF NINE LOTS OF BAYONETS

LOT	NO.	MFR.	BAYONET TYPE	YEAR OF MFG.	-2½	-2	-1½	-1	-3/4	-½	-1/4	0	+1/4	+½	+3/4	+1	+1-1/4	+1½	+2	+3	+4
					DISTANCE ** FROM FRONT OF GUARD IN INCHES																
F	1	Union Fork & Hoe Co.	M1	1943*	50	49	48	50	50	50	50	50	39	33	25	31	37	41	49	51	51
	2	" " "	"	"	49	49	49	50	48	49	50	50	41	23	28	34	40	43	48	49	50
	3	" " "	"	"	50	49	49	50	50	50	50	52	50	44	33	23	29	33	42	50	51
	4	" " "	"	"	50	50	50	50	51	46	49	36	24	31	36	38	42	48	48	50	49
G	1	Oneida Ltd.	"	1943	-4	-4	-5	-4	-3	-6	-5	-2	36	38	39	37	41	46	48	50	50
	2	" "	"	"	0	0	3	0	2	0	2	1	44	46	47	48	49	49	49	50	50
	3	" "	"	"	0	0	-3	-6	-2	-4	-4	0	1	31	38	45	46	44	47	48	49
	4	" "	"	"	3	2	4	0	-2	-4	4	2	8	20	48	49	49	51	51	50	51
H	1	Wilde Drop & Forge Mfg. Co.	M1905	1943	2	1	1	2	3	2	2	2	4	14	52	53	53	52	52	53	53
	2	Wilde Drop & Forge Mfg. Co.	M1905	"	2	0	4	3	9	5	4	53	52	54	54	53	53	53	53	54	53
	3	Wilde Drop & Forge Mfg. Co.	"	"	10	13	13	13	15	11	14	16	17	52	54	55	54	53	54	55	55
	4	Wilde Drop & Forge Mfg. Co.	"	"	2	1	1	3	5	5	17	22	26	51	52	52	52	52	52	52	53

APPENDIX A (CONT'D)

ROCKWELL "C" HARDNESS SURVEYS OF NINE LOTS OF BAYONETS

LOT NO.	MFR.		BAYONET TYPE	YEAR OF MFG.	$-2\frac{1}{2}$	-2	$-1\frac{1}{2}$	-1	$-3/4$	$-\frac{1}{2}$	$-1/4$	0	$+1/4$	$+\frac{1}{2}$	$+3/4$	$+1$	$+1\text{-}1/4$	$+1\frac{1}{2}$	$+2$	$+3$	$+4$	$+5$
					DISTANCE** FROM FRONT OF GUARD IN INCHES																	
I 6	Springfield Armory		M1905	1906	21	23	22	17	16	20	26	31	31	34	36	42	50	52	50	51	52	52
7	"	"	"	1907	21	23	22	18	17	19	24	32	34	36	37	39	41	42	44	48	47	47
8	"	"	"	1908	30	30	30	28	26	24	30	36	41	41	43	42	44	45	51	51	51	52
9	"	"	"	1909	26	32	31	26	23	27	29	30	35	37	39	40	42	41	42	42	43	43
11	"	"	"	1911	26	26	27	32	25	23	30	31	34	36	38	46	49	50	51	50	50	52
12	"	"	"	1912	30	30	31	30	29	29	33	41	43	43	44	47	47	48	51	51	51	51
13	"	"	"	1913	15	15	15	17	16	13	15	17	17	16	16	20	24	35	50	50	52	52
14	"	"	"	1914	13	15	16	14	16	11	16	26	32	36	41	48	47	48	49	50	50	51
15	"	"	"	1915	15	20	19	15	15	13	14	11	17	16	17	19	19	32	47	50	50	49
16	"	"	"	1916	4	0	2	5	3	2	2	4	5	5	8	11	22	33	38	44	44	45
17	"	"	"	1917	10	16	14	11	12	9	10	11	11	11	13	30	39	40	46	46	47	47
18	"	"*	"	1918	16	20	20	13	13	12	12	12	25	30	34	40	46	46	45	46	51	52

* Year of manufacture was not stamped on bayonet but probably is 1943.
** Direction of blade point is positive; direction of pommel is negative.

APPENDIX B

TRANSVERSE BEND TESTS OF WD-1080 STEEL BAYONET BLADES

Specimen No.	Rockwell "C" Hardness	Maximum Load Lbs.	Occurrence at Maximum Load
A-1	55-56	980	Fractured
A-2	54-55	980	"
B-1	51-52	970	"
B-2	51-52	750	"
C-1	49-50	980	Bent, No Fracture
C-2	49-50	960	" " "
D-1	47-48	820	" " "
D-2	46-47	700	" " "
E-1	44-45	770	" " "
E-2	44-45	825	" " "
F-1	37-38	600	" " "
F-2	37-38	570	" " "

Note 1 - These tests were made on the uniform portion of M1905 bayonet blades using a span of 6". The load was applied at the center of the span.

<u>APPENDIX C</u>

WAR DEPARTMENT

OFFICE OF THE CHIEF OF ORDNANCE
WASHINGTON, D. C.

SPOTS

Bird/mdl
Ext. 5845

25 November 1943

Subject: Bayonets, M1 and M1905 - Directive for Test of

To: Commanding Officer
Watertown Arsenal
Watertown, Massachusetts

<u>Attn: Colonel Zornig</u>

1. A large number of reports have been lately received from the field regarding breakages of bayonets manufactured by the Pal Blade Company. The breakage has uniformally occurred in the tang immediately to the rear of the bolster which supports the guard. Investigation has determined that since approximately 1923, and possibly considerably before that time, the tangs of bayonets, M1905 and M1 were not tempered. This was done with the possibly mistaken idea of providing a soft tang which would bend, rather than break, in use. Further investigation has shown that the heat treatment as used by Pal Blade Company provided an especially poor grain structure at the point of the tang directly to the rear of the bolster.

2. The Pal Blade Company was requested to temper the blade and tang completely through to the pommel. Preliminary tests of these blades indicate that bayonets manufactured by this method are superior to those of manufacture using the previous method leaving the tangs untempered.

3. Forwarded to your Arsenal are bayonets as follows:

<u>a</u>. 25 - Bayonets, M1905 of Springfield Armory or Rock Island manufacture made prior to 1923.

<u>b</u>. 25 - Bayonets, M1 of Pal Blade Company manufactured having heat-treated tangs.

<u>c</u>. 25 - Bayonets of Pal Blade Company manufacture having unheat-treated tangs.

d. 25 - Bayonets of current or late manufacture by each of the following facilties: Pal Blade Company, Union Fork and Hoe, Utica Cutlery, American Fork & Hoe, Wilde Drop Forge & Mfg. Company, and Oneida Limited.

4. It is requested that your Arsenal undertake a study of these bayonet samples in an effort to determine methods of heat-treating blades to provide the strongest and most durable bayonet.

By order of the Chief of Ordnance:

Rene' R. Studler
Colonel, Ordnance Dept.
Assistant

DEPARTMENT OF THE ARMY
UNITED STATES ARMY RESEARCH LABORATORY
ABERDEEN PROVING GROUND, MARYLAND 21005-5066

REPLY TO
THE ATTENTION OF

AMSRL-CS-IO-SC (380) 6 June 1997

MEMORANDUM FOR Defense Technical Information Center, 8725 John J. Kingman Road Suite 0944, Ft. Belvoir, VA 22060-6218

SUBJECT: Cancellation of Distribution Restrictions for Watertown Arsenal Laboratory Reports

1. References:

a. ~~AD-B962 843~~, Watertown Arsenal Laboratory Report No. WAL 320/29, "Bayonet Blades, Investigation of WD 10-80 Steel for Use in Bayonet Blades", 19 January 1944.

b. ~~AD-B962 712~~, Watertown Arsenal Laboratory Memorandum Report No. WAL, 739/87, "The Metallurgical Examination of a Japanese Samurai Sword", by J. I. Blum, 25 September 1946.

c. ~~AD-B962 710~~, Watertown Arsenal Laboratory Report No. WAL 739/47, "Bayonets, Metallurgical Examination of Six Lots of T2 Bayonets", 2 August 1944.

d. ~~AD-B962 687~~, Watertown Arsenal Laboratory Report No. WAL 739/48, "Bayonets, Metallurgical Examinaton of Eight M1 Bayonets Submitted by Springfield Armory", 8 August 1944.

e. ~~AD-B962 689~~, Watertown Arsenal Laboratory Report No. WAL 739/37, "Bayonets, Metallurgical Examination of Bayonets of Commercial and Springfield Armory Manufacture", 5 April 1944.

2. Our Laboratory has reviewed the reference reports and has approved them for public release; distribution is unlimited. Request that you annotate your records and mark the documents with distribution statement A in accordance with DOD Directive 5230.24.

3. Our action officer is Mr. Douglas J. Kingsley, telephone 410-278-6960

P. Ann Brown
P. ANN BROWN
Chief, Security/CI Branch
ARL, APG